MST e-News

March 2015
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INSIDE

Andy Nelson (right) and year-long Japanese visiting scientist Shun Hirooka measure thermophysical properties of uranium-based fuels and assess fabrication processes at Los Alamos National Laboratory's Fuels Research Laboratory. The lab is supported by DOE's Office of Nuclear Energy and the National Nuclear Security Administration.

Photo by Sandra Valdez, NIE-CS

Andy Nelson

Bolstering worldwide nuclear fuels research

By Diana Del Mauro, ADEPS Communications

Nelson said he is passionate about keeping the Fuels Research Laboratory dynamic and flexible for a variety of actinide research, with quick access to its capabilities.

Even before workers began removing more than 1,000 fuel rods from Japan's damaged Fukushima nuclear power plant, the country's scientists were running crucial experiments at Los Alamos's Fuels Research Laboratory (FRL), seeking to simulate and study the atypical oxide fuel reaction conditions resulting from the 2011 incident.

"The hope is that we both benefit," said Andy Nelson, who participates in and oversees the experiments as well as supervises the FRL's operations. Oxide fuel is also used in United States nuclear power plants.

The experiments were made possible by a 2013 bilateral agreement between Japan and the United States to coordinate nuclear research. Each Japan Atomic Energy Agency researcher spends a year at the FRL, pursuing mutually agreed upon projects using the lab's powerful suite of tools. The third Japanese scientist arrived last spring. The visits are a more efficient means of obtaining valuable and timely

continued on page 2

From David's desk . . .

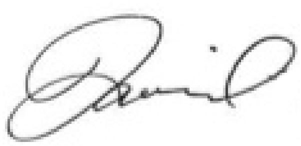
One of the topics I discussed in my recent All Hand's briefings was the need for us all to be diligent in our observation of safety in our work environment. LANL has been having an increase in electrical incidents over the past year including several minor electrical shocks, and MST is not immune. Electrical safety is an area where we need to continue to be vigilant so that we can come to work safe and return home safe.

Recently we had a near-miss in MST where a worker almost received an electrical shock while performing a chemical cleaning operation. Luckily, the chemical-resistant gloves provided enough protection to prevent a shock to the worker. It was determined that the arc from an overhead hoist was caused by equipment failure, which allowed 120 V (one phase of the three phase 208 V system) to energize the hoist cable. The tool used by the worker completed a path to ground. There was no work control error on anyone's part. It should be noted that the overhead hoists were scavenged from old systems due to lack of funding to buy new ones. An upcoming investigation will determine why the phase shorted to the case, and why the ground did not shunt the short.

Similarly, a postdoc in P-25 received a very minor shock caused by a 55 V ac, 1 mA current leakage through the electronics. The worker felt a minor tingling. This energy is well below any injury threshold. The issue was that the ground in the branch circuit in this 40-year-old facility was inadequate to shunt the leakage current. The primary cause was equipment failure in an aging facility.

Another event occurred several months ago at AOT, where a worker received a minor burn when an electrical cord shorted to an electrical rack cabinet, causing molten metal to spray onto the worker. The investigation determined that the insulation on the electrical cord had frayed due to age and lack of cable restraint. When the worker bumped into the cord while walking nearby the cabinet, the bare conductors came into contact with the frame and created the electrical short.

"Electrical safety is an area where we need to continue to be vigilant so that we can come to work safe and return home safe."

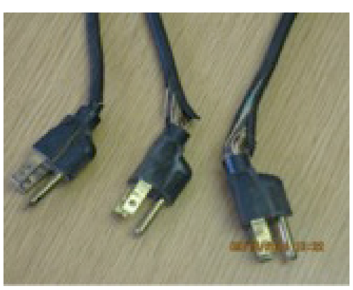


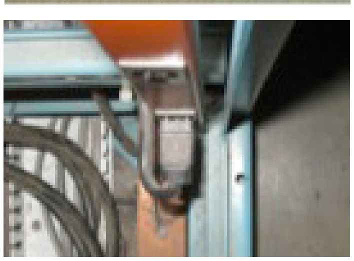
Note that in each of these cases, the workers were performing work safely and following approved procedures. However, in each case aging or modified equipment created a condition that caused an electrical safety concern. Although MST has had recent success in upgrading some of our experimental capabilities, much of our experimental equipment is significantly old and we may have similar conditions in our laboratories, of which we may not be aware. I would like for each of you to inspect your workspaces for potential electrical concerns that could be related to aging or equipment modification. We may not be able to identify facility-related issues, but we certainly can assess our experimental equipment. If you do identify a facility-related issue, please notify both your RLM and the FOD. If you have identified an issue with your own equipment, please involve a group electrical safety officer (ESO) to determine the best path forward.

Lastly, I would like to express my appreciation for the service our ESOs provide to the Division. They have a very important job helping us maintain a safe electrical work environment. Again, contact your group electrical safety officer and/or our division electrical safety officer if you have any questions or would like them to perform a review of your operations.

Division ESO: Kevin Henderson
MST-6 ESOs: Don Bucholz, Matt Strady, Jacob Sutton and Justin Tokash
MST-7 ESO: Kevin Henderson
MST-8: Carl Cady, Bob Houlton and Matt Reiche
MST-16: Michael Ramos

MST Division Leader David Teter





At left: Examples of faulty cords identified, and subsequently repaired or replaced, after an AOT employee received a minor burn from a frayed 120 VAC power cord that produced an arc. Power cords degrade over time due to heat and climate. Inspect your work area to identify and analyze hazards.

Nelson cont.

data than Japan constructing a similar facility, Nelson said. The Department of Energy Office of Nuclear Energy (DOE-NE) funded construction of the FRL for the study of existing and development of new nuclear fuels. (Read about the collaboration's first published results, page 5).

The Fukushima incident was "a big realization about what we don't understand about light water nuclear reactors," which are in use around the world, Nelson said. With FRL data, researchers contribute to improved predictions of radioactive fallout in off-normal situations, leading to a science-based decision-making approach about how to respond, such as deploying work crews or evacuating communities or cleaning up the damage, he said.

In 2011, the Laboratory recognized Nelson (Polymers & Coatings, MST-7) with an internal award for managing the start-up of radiological work at the FRL, a complex feat for a facility open to national and international scientists, postdoctoral researchers, and students: 20 percent of DOE-NE's budget is allotted for university research. Nelson said he is passionate about keeping the FRL "dynamic and flexible" for a variety of actinide research, with quick access to its capabilities.

The lab provides a "specialized set of fuel synthesis and characterization capabilities that is unique in the United States," said Kenneth McClellan (Materials Science in Radiation & Dynamics Extremes, MST-8). Nelson and his team "support and enable development of uranium- and thorium-based nuclear fuel systems, which is especially relevant as, for the first time in many years, the nuclear community looks to develop new and safer fuels for commercial power generation and for smaller-scale, special purpose reactors."

Nelson screens and monitors all experiments, consulting with materials and safety experts before launching projects that can employ a range of equipment—lasers, gases, and powerful electrical sources, as well as radioactive materials.

He began guiding this meaningful work two years after earning his doctorate in nuclear engineering and engineering physics. "I love what I'm doing," said Nelson, who recalled as a toddler being fascinated watching molten metal solidify in the shop where his father taught high school welding.

Switching his college studies from engineering mechanics to nuclear engineering gave Nelson, who initially considered becoming an aerospace engineer, a wide breadth of knowledge when he finished his PhD in 2009—and his diverse skillset equips him to adapt to customer needs.

McClellan, his mentor, said Nelson was "the natural choice to take over the FRL as it started up … As a postdoc working on the Fuel Cycle R&D program, Andy had personified the special skillset required for success in advanced fuels research, namely, the ability to integrate the design and performance requirements from a nuclear engineering perspective (his degree) along with the understanding of the chemistry/process/structure/performance relationships (materials science) that control fuel performance."

Andy Nelson's favorite experiment

What-Why: After the disaster at Fukushima, the DOE-Nuclear Energy Advanced Fuels Campaign began investigating options to improve the "accident tolerance" of existing commercial reactors. One proposed family of compounds was uranium-silicides. Limited data suggested uranium-silicides might possess attributes that could extend the "coping time" before an accident like Fukushima would result in radioactivity release. Little, however, was known about many of their basic properties.

When: In late 2013, Materials Science and Technology Division researchers began a collaboration to produce U-Si compounds and systematically measure their properties to support (or disprove) their continued evaluation.

Where: Fuels Research Laboratory at Los Alamos National Laboratory

Who: Darrin Byler and Ken McClellan (Materials Science in Radiation and Dynamics Extremes, MST-8) synthesized high purity U_3Si, U_3Si_2, USi, and U_3Si_5, and Joshua White, John Dunwoody, and I (Polymers and Coatings, MST-7) developed powder metallurgy methods for producing high density samples.

How: We then measured the thermal conductivity, heat capacity, and thermal expansion of all four compounds from room temperature to their respective melt points (>1200K).

The "a-ha moment:" The data collected resolve decades of conflicting reports. More interesting, oxidation testing revealed that U_3Si_2, originally a top candidate, oxidizes much more easily than current uranium dioxide. This result shifted our focus to the Si-rich compounds, which have demonstrated improved thermal conductivity and could comprise a new generation of more robust nuclear fuels.

Andersson recognized for excellence in advancing nuclear fuels models and simulations

David Andersson (Materials Science in Radiation and Dynamics Extremes, MST-8) is a co-recipient of the 2014 Excellence Award from the leadership team of the DOE Nuclear Energy Advanced Modeling and Simulation (NEAMS) Program. Andersson, with Michael Tonks and Richard Williamson (Idaho National Laboratory), was recognized for "sustained leadership in developing multiscale mathematical models and computer simulations of nuclear fuels that have advanced the state of the art in the field and have added substantial value to the NEAMS Toolkit."

The "NEAMS Toolkit" refers to new computation tools, based on first-principles physics models instead of status quo empirical math models, to provide the predictive simulation capability required for the development of high performing, safe, clean, and economical advanced reactor systems.

As part of DOE's Office of Nuclear Energy, NEAMS supports research and development to study physical phenomena that drive the behavior of materials, captured by three-dimensional physics models and simulations, which could give designers of new fuels and reactor types the ability to predict how their new systems would behave in a range of conditions. In the area of new fuel systems—which could boost how efficiently a reactor produces power and how much nuclear waste it produces—there is an urgent need to speed up the steps of manufacturing fuel, building a fuel assembly, testing a fuel system in a reactor, and evaluating the results. These steps currently require years to accomplish. Andersson's research aims to reduce the time and cost of screening different materials and design configurations, from the micro-structural level to individual pellets to entire rods and bundles. He uses atomistic simulations to develop material models for application in the MARMOT microstructure code and BISON fuel performance code.

Andersson earned a PhD in materials science and engineering from the Royal Institute of Technology (KTH), Sweden. He joined LANL in 2007 and is a scientist on MST-8's Radiation Science, Nuclear Materials, and Fuels Modeling Team. His NEAMS research supports the Laboratory's Energy Security mission area and the Materials for the Future science pillar through the development of models for nuclear reactor fuels.

The Office of Nuclear Energy's mission is "to advance nuclear power as a resource capable of meeting the Nation's energy, environmental, and national security needs by resolving technical, cost, safety, proliferation resistance, and security barriers through research, development, and demonstration as appropriate." The NEAMS Awards, which also includes recognition for team building and innovation, are presented annually by the NEAMS leadership team, which includes its leadership council, national technical director, and the DOE Office of Advanced Modeling and Simulation.

Technical contact: David Andersson

Using magnetic measurements to detect hydrogen contaminants in plutonium

Using magnetization, x-ray, and neutron diffraction measurements enabled by materials science capabilities at Los Alamos National Laboratory, scientists have demonstrated a technique for detecting low concentrations of plutonium hydride in samples.

The technique, published in the *Journal of Applied Physics*, is relevant to plutonium applications, workers who handle plutonium, and long-term plutonium storage. Contaminants, such as oxygen, hydrogen, and carbon, can degrade the mechanical properties of plutonium, causing consequences that can negatively affect health and safety.

Focusing on the effects of plutonium metal exposed to low levels of hydrogen during the radioactive decay process, Los Alamos researchers show that ferromagnetic remanence—the residual magnetization left in a ferromagnetic material (a permanent magnet) after exposure to a magnetic field—can detect small quantities of hydrogen against the background of pure plutonium. Pure plutonium is non-magnetic; however, researchers at LANL in the early 1960s discovered that the metal acquires a magnetic moment when it reacts with hydrogen to create plutonium hydride. Therefore, magnetic measurements can be used to detect the presence of hydride formation in plutonium metal.

Looking at samples of polycrystalline delta-plutonium stabilized with gallium, the researchers characterized the metallic crystal structures using the Neutron Powder Diffractometer (NPDF) and neutron diffraction at the Los Alamos Neutron Science Center (LANSCE), and found the samples to have the expected fcc structure and lattice parameters. In preparation for the magnetization measurements, the samples were exposed to hydrogen under partial vacuum at 450 ºC to ensure reproducible hydrogen solubility. One sample was loaded to a H/Pu atom ratio of 0.01 ± 0.0003; the second Pu sample was encapsulated without H loading.
After sealing the samples in titanium containers in order to

continued on next page

Hydrogen cont.

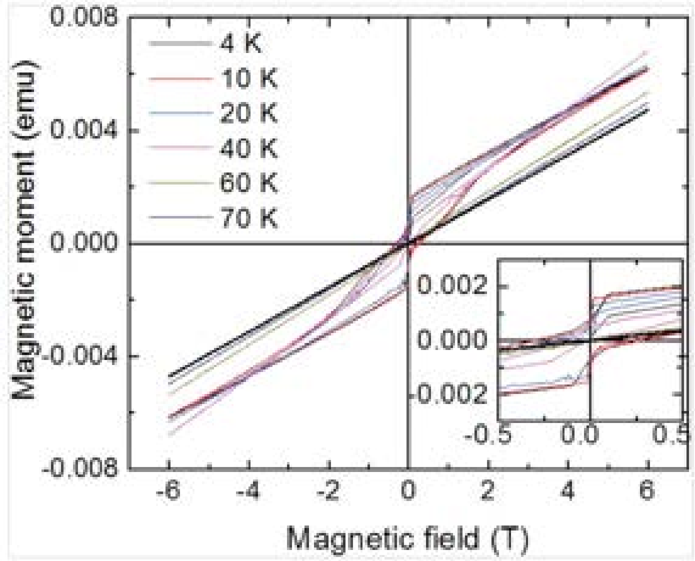
prevent radioactive contamination of the surroundings or exposure of the samples to air, the scientists measured the magnetization of the capsules as a function of magnetic field and temperature. They did so using a commercial vibrating sample magnetometer in a physical properties measurement system at the National High Magnetic Field Laboratory-Pulsed Field Facility. The results confirm that the 2.0 at.% Ga stabilized H-free δ-Pu samples are non-magnetic between 4-300 K.

The outcome showed that commercial magnetization measurement techniques are sensitive to the conversion of tiny amounts (0.0015 mol fraction) of hydrogen in Ga stabilized δ-Pu to ferromagnetic PuH x. This easily reproducible technique is a useful quantitative diagnostic to determine the content of small amounts of PuH x in samples.

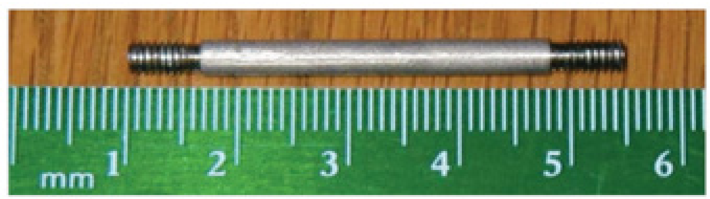
Work at LANL was supported by the Laboratory-Directed Research and Development program. Magnetization measurements were performed at the National High Magnetic Field Laboratory, funded by the U.S. National Science Foundation through Cooperative Grant No. DMR-1157490, the State of Florida, and the U.S. Department of Energy. The neutron diffraction work was performed on the Neutron Powder Diffractometer at the Lujan Neutron Scattering Center, supported by DOE-Basic Energy Sciences under FWP No. 2012LANLE389.

Reference: "Detecting low concentrations of plutonium hydride with magnetization measurements," *J. Appl. Phys.* **117**, 053905 (2015), Jae Wook Kim (now at Rutgers Center for Emergent Materials, Rutgers University); Eundeok Mun (now at Simon Fraser University, Canada), Joe Baiardo, Vivien Zapf, Chuck Mielke (Condensed Matter and Magnet Science (MPA-CMMS); Alice Smith, Scott Richmond, Jeremy Mitchell, Dan Schwartz (Nuclear Materials Science, MST-16).

Technical contacts: Dan Schwartz and Chuck Mielke



Magnetic moment as a function of magnetic field of δ-Pu with 1 at.% H exposure in Ti sample holder, minus the magnetization of the sample without H exposure in Ti sample holder. Measurements were conducted at. after zero-field cooling (in $H<10^{-3}$ T) from room temperature and sweeping the magnetic field around a 6 T hysteresis loop starting from $H=0$. The inset shows a zoomed view of the magnetic hysteresis, with a linear background subtracted.



After sealing the plutonium samples in titanium containers, the scientists measured the magnetization of three capsules as a function of magnetic field and temperature at the National High Magnetic Field Laboratory at Los Alamos.

CeO_2 surrogate is not PuO_2's equal in nuclear fuel studies

First published results from joint U.S.-Japan effort

For decades, scientists have used cerium dioxide (CeO_2) in the laboratory as a surrogate material to explore the synthesis and properties of nuclear fuel forms, or processes involving plutonium dioxide (PuO_2) such as mixed oxide fuel. Unlike plutonium or uranium, CeO_2 is not radioactive; therefore, it is easier and less costly to work with across more laboratories.

Yet until Japan Atomic Energy Agency (JAEA) and Los Alamos researchers ran experiments at the Los Alamos Fuels Research Laboratory (FRL), no one had investigated how accurate or inaccurate CeO_2 is as a surrogate. The most significant differences turned out to be in the thermochemistry between a $(U,Ce)O_2$ surrogate and a $(U,Pu)O_2$ fuel, according to their research in the *Journal of the American Ceramic Society*.

CeO_2 will much more readily reduce than PuO_2; even the oxygen content of ambient air is insufficient to prevent oxygen vacancies from building into the lattice over time at room temperature. Although this difference has been qualitatively understood, the extent to which these vacancies degraded the properties of CeO_2 as a function of temperature was not

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Hydrogen cont.

known. The thermal conductivity of oxide materials is particularly sensitive to structural defects, and its importance to the design of nuclear fuels and reactor operation is critical.

At the FRL, the researchers determined the thermal conductivity of stoichiometric CeO_2 based on high-temperature measurements of thermal expansion, thermal diffusivity, and heat capacity. The thermal conductivity of stoichiometric CeO_2 was found by calculating the product of density, thermal diffusivity, and heat capacity. Each of these three parameters was measured as a function of temperature by dilatometry, laser flash analysis, and differential scanning calorimetry, respectively. They compared the results to the existing literature data for CeO_2, PuO_2, as well as uranium dioxide (UO_2), the most widely used nuclear fuel today.

How important the differences are depends on the point of an investigator's research, but now scientists can quantify the differences. The findings:

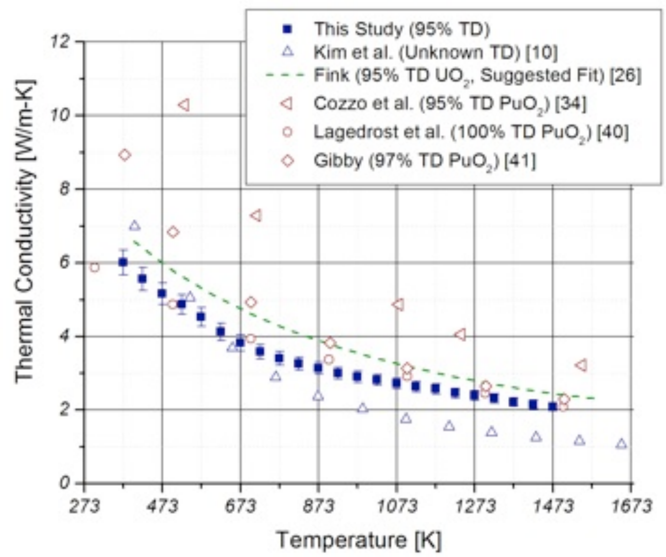
- Across the board, the thermophysical properties of CeO_2 did not match PuO_2.
- The thermal conductivity of CeO_2 was generally comparable to UO_2 below 1673 K, but not at higher temperatures. This might make CeO_2 an acceptable surrogate UO_2-based composite materials where off-stoichiometry can be controlled.

This is the first publication resulting from an ongoing collaboration between Los Alamos National Laboratory and JAEA. (For more about the collaboration, please see the cover story). The Civil Nuclear Energy R&D Working Group was formed between the United States and Japan to conduct cooperative nuclear energy research and development in such areas as advanced reactor and fuel cycle technologies and existing reactor fleet sustainability. Under that umbrella organization, the Fuel Cycle R&D and Waste Management sub-working group project was created in 2013, and it is through that particular project that the nuclear fuels work is being performed at Los Alamos.

The JAEA and Los Alamos collaborators are studying the U-Ce-O system and the thermophysical properties of its constituents. They are executing broad studies to understand what oxygen activity is required to drive a specific off-stoichiometry in $(U,Ce)O_2$ surrogates, and then measuring properties like thermal conductivity as a function of cerium content and off-stoichiometry. As the collaborators better understand both the thermochemistry and thermophysical properties of $(U,Ce)O_2$, they can execute expansive studies at Los Alamos to get a detailed idea of how this system works. Once they have experimental data and appropriate models for $(U,Ce)O_2$, they can identify perhaps 3-4 key experiments that can be done at JAEA on $(U,Pu)O_2$ to validate (or disprove) extrapolated models that the collaborators build based on their vast $(U,Ce)O_2$ data. This is critical because the difficulty of working with plutonium means that JAEA can perhaps execute 1 experiment for every 20-30 experiments that researchers can run at the Los Alamos FRL.

The U.S. Department of Energy, Office of Nuclear Energy Fuel Cycle Research and Development program funded the work, with the U.S. Department of Energy Nuclear Energy University Program supporting portions of the work. The work benefited from the use of the Fuels Research Laboratory, which is funded by DOE's Office of Nuclear Energy and the National Nuclear Security Administration. The research supports the Laboratory's Energy Security mission and Materials for the Future science pillar. Reference: "An Evaluation of the Thermophysical Properties of Stoichiometric CeO_2 in Comparison to UO_2 and PuO_2," *J. Am. Ceram. Soc.* **97** 11 (2014), Andy Nelson, Dylan Rittman, Joshua White, John Dunwoody (Polymers & Coatings, MST-7); Masato Kato (JAEA); and Kenneth McClellan (Materials Science in Radiation & Dynamics Extremes, MST-8)

Technical contact: Andy Nelson



Thermal conductivity data for CeO_2 as determined here compared to the accepted fit for UO_2 and available data for PuO_2. The theoretical densities for each set of data are shown in the legend.

Celebrating service

Congratulations to the following MST Division employees celebrating service anniversaries recently:

Michael Mauro, MST-6	35 years
Victor Vargas, MST-6	35 years
George (Rusty) Gray, MST-8	30 years
Jeremy Mitchell, MST-16	20 years
Ruth Ann Vargas, MST-6	20 years
Paulo Rigg, MST-8	15 years
Daniel Coughlin, MST-6	10 years
Xiang-Yang Liu, MST-8	5 years

LANL streamlining production through additive manufacturing

With the recent installation of an EOS M280 direct metal laser sintering (DMLS) machine, Los Alamos National Laboratory is additively manufacturing stainless steel parts for a portable γ-ray imaging system.

Additive manufacturing, which uses computer-aided designs to build 3D components, is significantly more efficient than conventional fabrication methods. The effort is also an example of the process-aware manufacturing to be employed at MaRIE (Matter-Radiation Interactions in Extremes), the Laboratory's proposed experimental facility. MaRIE will improve predictive capability for materials and accelerate the qualification, certification, and assessment of those materials for national security missions.

Figure 1: CAD rendering for Cobalt Pig steel components.

Purchased with LANL Strategic Capital Investment Funds provided by the Principal Associate Directorate of Science, Technology, and Engineering to be a joint venture by Metallurgy (MST-6) and Applied Engineering Technology (AET-1), the EOS M280 is a metal powder bed-based additive manufacturing machine that fabricates parts through sequentially sintering 20-40µm thick cross sections. Through the repetition of steps that include laser sintering a part cross section, dropping the building surface, recoating the powder bed, and sintering the subsequent part cross section, a component can be systematically built. The total build volume of the system is 10"×10"×12"—meaning that metal components of significant size can be fabricated from computer-aided-design (CAD) files, as shown in Figure 1 for the Cobalt Pig project.

The Cobalt Pig project, funded by NEN-2, formed the first production runs of the EOS M280 after installation. The 15-5 stainless steel parts for this project, a portable γ-ray imaging system, were initially designed for conventional manufacturing and involved 10 components and 6 weldments. With the known capabilities of the EOS M280 the complexity was reduced significantly, to only four components and two weldments. Additionally all parts were fabricated in a single build cycle. The first set of these components were completed in February 2015 and are shown in Figure 2.

Figure 2: First completed set of components for the Cobalt Pig.

The process of powder bed-based additive manufacturing requires features at less than 30° from the plane of the baseplate to be supported by partially sintered support material. This support material is similar to a honeycomb structure and has the benefit of being both rigid and brittle, making it easy to remove after fabrication. Supports are necessary to fix the component to the baseplate, as well as to act as a heat sink in order to avoid thermal gradient-based distortion in as-fabricated parts. If parts are not supported properly, feature tolerance can be significantly degraded to the point where the assembly may not fit together properly. An example of the interaction of support material and part in the build process is shown in Figure 3. The lighter gray material is the partially sintered support structures, which fix the fully dense part to the baseplate.

After fabrication the support structure is carefully broken away from the components and the surfaces are cleaned and awaiting final assembly shown in Figure 4.

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Additive cont.

Figure 3: As deposited Cobalt Pig Components with support structure attached.

Figure 4: Final assembly of Cobalt Pig components.

Future work on the EOS M280 will continue to be a cooperative effort between MST-6 and AET-1 and will be focused on weapons program support, high-temperature rocket engines, and enhanced efficiency heat exchangers.

This work supports the Laboratory's Nuclear Deterrence and Energy Security mission areas and the Materials for the Future Science pillar.

Participants in this project include Don Bucholz, Michael Brand, John Carpenter, Dave Alexander, Rick Hudson, Mark Paffett and Cameron Knapp (Metallurgy, MST-6); as well as Larry Bronisz, John Bernardin and Don Quintana (Applied Engineering Technology, AET-1)

Technical Contact: Don Bucholz

Dynamic density field measurements of an explosively driven α–ε phase transition in iron

Los Alamos researchers recently completed a novel experiment providing quantitative density and kinetic data for comparison with advanced physical/computational treatments, either existing or in development, of a first-order shock-induced phase transformation.

Most studies of the α–ε phase transition have employed uniaxial shock wave loading. For a given material subjected to a uniaxial shock (plane, one-dimensional shock wave), the shear stress throughout both any elastic precursor and the plastic wave are uniquely related to the amplitude. This phase transition in iron has been well studied due to the element's prevalence in the earth's crust and its use in steel and its various alloys.

In this work, Los Alamos researchers provided measured density distributions, dynamically measured at 5 times using the Dual Axis Radiographic Hydrodynamic Test Facility (DARHT) at LANL, of an iron sample undergoing the α–ε phase transition from loading induced by a detonation wave sweeping along one surface. This loading path differs from one-dimensional shock wave loading because there are regions of shear developed in the sample that are an evolving function of the obliquity with which the detonation wave interacts with the sample, and consequent shock and elastic wave reflections from the free surface of the iron.

Shocked regions and boundaries were measured, as well as regions and boundaries of elevated density (presumed to be the ε-phase iron). The formation and dynamics of these regions were captured and are available for comparisons to material descriptions. The researchers also applied 16 photon Doppler velocimetry (PDV) probes to capture the free surface velocity along a discrete set of radially distributed points in order to compare and correlate the density measurements with previous shock wave studies. The velocimetry data are in nearly exact agreement with previous shock wave studies of the α–ε phase transition, the density distributions, while generally in agreement with expectations evolved from the shock wave studies, show for the first time quantitatively that the epsilon phase is generated in regions of high shear stress but at hydrostatic stresses below the typically quoted 13 GPa value. The density field measurements are particularly useful for observing the effects of the forward and reverse transformation kinetics, as well as the reverse transformation hysteresis that is also not predicted in current multi-phase equation of state descriptions of iron.

Future facilities like MaRIE will take this research into phase transition kinetics and the importance of stress-state on shock-induced transitions even further by facilitating direct coupling of the shock-induced transition microstructure with the initial starting material microstructure.

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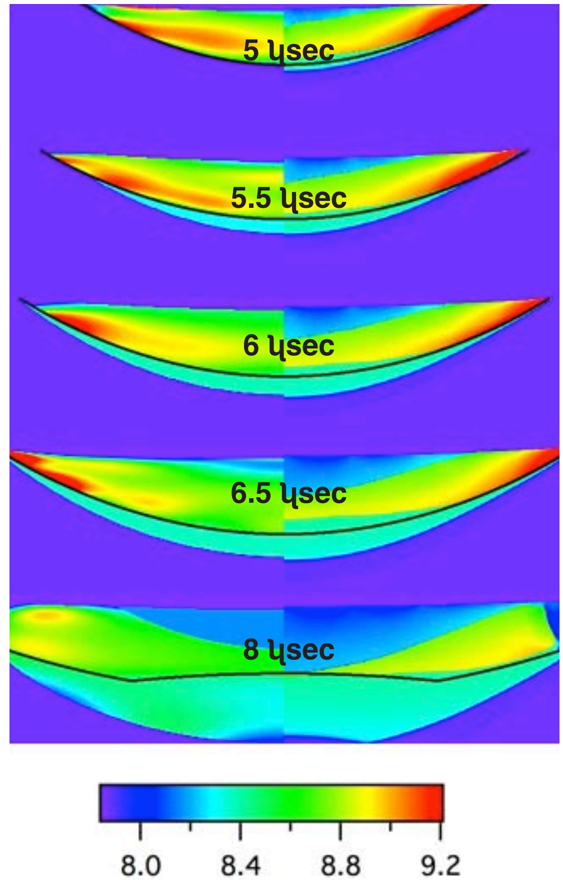
Density cont.

Authors include Larry Hull (Focused Experiments, WX-3), George T. (Rusty) Gray III (Materials Science in Radiation and Dynamics Extremes, MST-8), and Barry J. Warthen (DARHT Experiments and Diagnostics, WX-4).

The execution of an experiment at a large facility such as DARHT necessarily involves large numbers of people and often their predecessors. Various funding sources are also involved. Special recognition is given to the accelerator and operations teams, the gamma-ray camera team, the PDV team, and the mechanical design team, because each fine-tuned its respective contributions to make this particular experiment so successful.

Science Campaign 2 (LANL Program Manager Rick Martineau) and Department of Defense/Department of Energy Joint Munitions Program (LANL Program Manager Thomas Mason) funded the work, which supports the Lab's national security science mission and Materials for the Future science pillar. Reference: "Dynamic density field measurements of an explosively driven α–ε phase transition in iron," by L.M. Hull, G.T. Gray III, and B.J. Warthen, *J. Appl. Physics*, **116** (2014).

Technical contacts: Larry Hull and George T. (Rusty) Gray III



The measured density data (g/cm^3, at times relative to initiation of PBX 9501) are in the left half of the figure and the calculated data are in the right half.

Materials science series offer early-career researchers chance to broaden horizons

For early-career researchers looking to broaden their knowledge of the Laboratory, for ways to spark new collaborations across organizations, or to receive expert coaching from a Laboratory Fellow before presenting their latest technical results, the New Year offers two outstanding series.

MS Cookies & Tea, which aims to connect postdoctoral researchers and early-career staff with Laboratory senior staff, program managers, and management through informal presentations and discussions on a range of Laboratory issues, has returned with events held on the first and third Wednesdays of the month. Technical and non-technical talks are followed by a half-hour of refreshments, informal discussion, and networking. Meetings are open to all employees. Materials Science and Technology and Materials Physics and Applications divisions organize the gatherings with support from the Institute for Materials Science. Send ideas for speakers or topics to hosts Ming Tang (Materials Science in Radiation and Dynamics Extremes, MST-8, mtang@lanl.gov) or Blake Sturtevant (Materials Synthesis and Integrated Devices, MPA-11, bsturtev@lanl.gov).

The April 1 MST Cookies & Tea will feature Principal Associate Director Global Security Terry Wallace speaking on "The Science of National Security." The event will be held from 4-5 p.m. in the MSL Auditorium (TA-3, SM-1698, Rm. 103). On April 15 James L. Smith (Metallurgy, MST-6) will present "Succeeding at the Lab." (see more about Smith below).

The **James L. Smith Materials Postdoc/Early Career Seminar** is a new showcase for materials-related research from Laboratory postdoctoral researchers and early-career staff. Seminars will be held every two weeks. Prior to their presentation, speakers will discuss their work and career goals with Smith (Metallurgy, MST-6), giving them an opportunity to receive feedback from an enthusiastic retired Laboratory Fellow. Throughout his 40-year career at Los Alamos, Smith, who has a PhD in physics from Brown University, has been and continues to be an active mentor and champion of early-career LANL scientists. The seminar series is organized by the Materials Science and Technology and Materials Physics and Applications divisions. To suggest presenters, contact hosts Seth Imhoff (Metallurgy, MST-6, sdi@lanl.gov) or Jinkyoung Yoo (Center for Integrated Nanotechnologies, MPA-CINT, jyoo@lanl.gov).

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Series cont.
The April 13 postdoc/early career seminar will feature Navaneetha Subbaiyan (MPA-CINT) discussing interface engineering using supramolecular chemistry for energy harvesting, catalysis, and separation. The talk will be at 11 a.m. in the MSL auditorium (TA-3, SM-1698, Rm. 103).

HeadsUP!

ADEPS Environmental Action Plan for FY15

Environmental management will always be an ongoing effort. Our 2015 Environmental Action Plan addresses our impact on the environment and outlines steps we can take to reduce our impact and decrease the potential for, and severity of, any environmental damage.

We again focus upon three objectives: Clean the Past; Control the Present; and Create a Sustainable Future. These objectives parallel the LANL institutional objectives, with the targets fine-tuned to fit our Directorate's needs.

Clean the Past: ***Reduce Environmental Risks from Historical Operations, Legacy and Excess Materials, and Other Conditions Associated with Activities No Longer a Part of Current Operations.***

Target 1: Ensure testing is continuing on our peroxide-forming chemicals; update the current inventory of all peroxide-formers.
Target 2: Reduce ADEPS surplus equipment, salvaging or recycling wherever appropriate; inventory and work to minimize use of transportainer storage units; reduce total volume of chemical containers; properly disposition unwanted/unneeded office and lab items; properly disposition legacy records and documents.
- Action 1: Reduce, Salvage and Recycle
- Action 2: Transportainer Inventory, Clean-out, and Removal
- Action 3: Combined Effort: MPA/MST Clean Up of Rad-Contaminated Vacuum Pumps and other Legacy Items from 03-34. (Contingent on available funding)
- Action 4: Transfer hazardous chemicals from LANSCE to ORNL-SNS
- Action 5: Establish a common staging area for MST/MPA for salvaging/recycling.

Control the Present: ***Control and Reduce Environmental Risks from Current, Ongoing Operations, Missions, and Work Scope.***

Target 1: Managers will conduct at least one environmentally-focused MOV in each quarter.
Target 2: Perform annual chemical inventories (90% of ChemLog entries inventoried).
Target 3: Communicate environmental objectives to the Directorate
Note: *all three targets are assessed on an annual basis.*
Create a Sustainable Future: ***Reduce or Eliminate the Use of SF6 Green House Gas (GHG) by Recycle/Reuse or Replacement Activities.***

Target 1: Support institutional efforts towards SF6 reduction, elimination, and/or reclamation of this egregious GHG (greenhouse gas).
Target 2: If funded, advance the design and prep phases of the SF6 P2 project in the P23 Turbulence Lab.

Additionally:
We need you to turn off lights in offices, conference rooms, hallways, and labs when not in use. Get that leaking faucet/toilet/urinal fixed (contact your facilities coordinator). Turn off computer peripherals when not in use. Alter your purchasing habits–Purchase GREEN. Use the blue and green recycling bins. Share chemicals, minimize chemical inventories, purchase safer alternatives, recycle and dispose properly. Salvage all unnecessary or unused (and not needed) equipment. Nominate a deserving colleague for a P2 Award!!

Document, Record & Report all significant environmental actions that you take that positively affect the environment. Remember, if it's not recorded, it didn't happen. Please send your environmental action updates to your Division's EAP contact (MPA: Susie Duran at susiew@lanl.gov; MST: Dan Thoma at thoma@lanl.gov; P: Steve Glick at sglick@lanl.gov). This will ensure that our Directorate continues to get the recognition it deserves for our environmental efforts.

The plan in greater detail can be found at the LANL EMS web page at int.lanl.gov/environment/ems/index.shtml; then click on Tools-"EMS Action Plans."

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